INTERCOMPARISON BETWEEN VLBI FREQUENCY TRANSFER AND OTHER TECHNIQUES

Hiroshi Takiguchi[1] (htaki@nict.go.jp), Y. Koyama[1] , R. Ichikawa[1] , T. Gotoh[1] ,
A. Ishii[2], T. Hobiger[1], M. Fujieda[1], J. Amagai[1], and M. Hosokawa[1]

[1] *National Institute of Information and Communications Technology, 893-1 Hirai, Kashima, Ibaraki, 314-8501, Japan*
[2] *Advanced Engineering Services Co., Ltd., 1-6-1 Takezono, Tsukuba, Ibaraki, 305-0032, Japan*

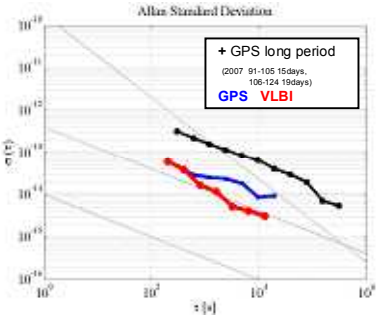
Introduction

As one of the new frequency transfer technique to compare the next highly stable frequency standards, we proposed the **geodetic VLBI technique**.

1. Developing a compact VLBI system
MARBLE SYSTEM
Multiple Antenna Radio-interferometry of Baseline Length Evaluation

2. Verifying the ability of VLBI frequency transfer
to show the capability of the current VLBI system
→ Intercomparison between VLBI and other techniques

Previous Study
Comparison between VLBI and GPS using IVS and IGS data



Onsala-Wettzell baseline
at each site
VLBI and GPS are *sharing* the H-maser

In general, the VLBI frequency transfer stability follows a $1/\tau$ law very close when averaging up to **10^4s**.

The geodetic VLBI technique has the potential for precise frequency transfer

Development of a Compact VLBI System

We are developing a compact and transportable VLBI system to certificate the length of the reference baseline, based on a collaboration between Geospatial Information Authority of Japan and NICT.

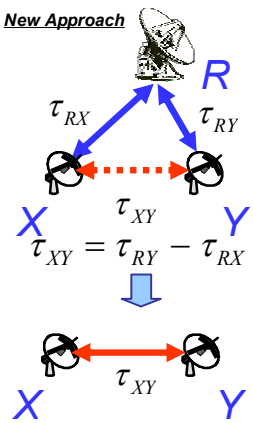
prototype #1 @KSRC, NICT
prototype #2 @GSI

MARBLE SYSTEM
(Multiple Antenna Radio-interferometer of Baseline Length Evaluation)

- Diameter **1.6m**
- S/X-band
- Front-fed paraboloidal reflector
- Az-El mounting
  Max speed AzEl **5 deg/sec**
- Transportable by **few person**

now under test experiment

New Approach

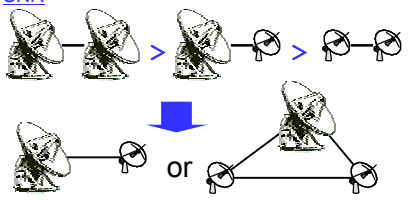


That is calculate the group delay of compact-compact antenna baseline from the two large-compact antenna baseline.

Basic Approach

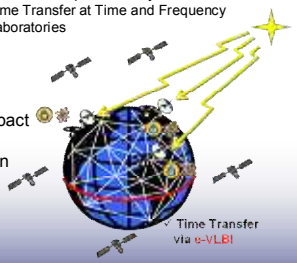
$$SNR \propto \frac{D_1 D_2}{\sqrt{T_1 T_2}} \qquad \sigma = \frac{1}{SNR}$$

SNR



Future image

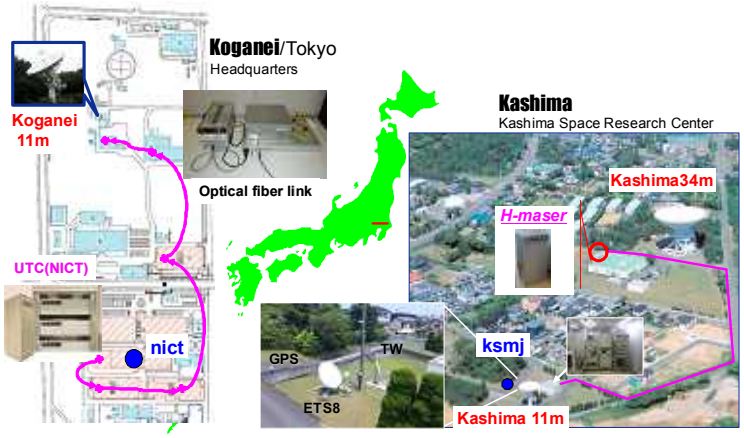
collocate compact VLBI systems for Time Transfer at Time and Frequency Laboratories



Advantages:
- could not consider the sensitivity of the compact-compact antenna baseline
- short integration time and increase the number of scan
- cancel the effects of the large antenna's problems (gravitational and thermal deformation)

Intercomparison between VLBI and Other Techniques

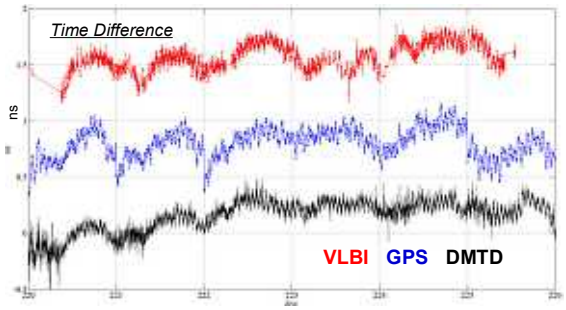
NICT has several T&F transfer techniques other than VLBI such as using GPS and telecommunication satellites at NICT Koganei Headquaters and Kashima Space Research Center.



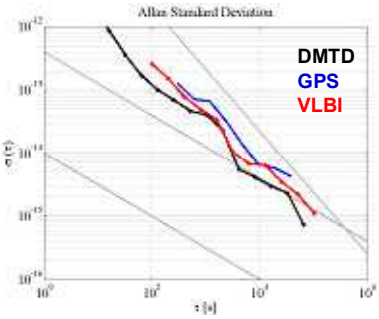
to show the capability of the current VLBI system
→ Intercomparison between VLBI and other techniques

Kashima 34m — Kashima 11m baseline

VLBI (multi channel sampling), GPS Carrier Phase, DMTD(Dual Mixer Time Difference)



Frequency Stability

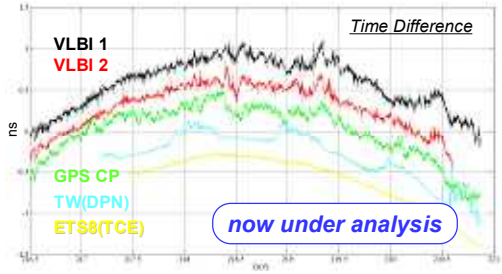


Summary

- Time differences
  VLBI vs. GPS and DMTD
  Good agreement : **±500ps**
- VLBI is more stable than GPS
  same baseline and same period
  over **10^3** averaging time
- VLBI stability : follows a **$1/\tau$**

Latest Observation

Kashima – Koganei baseline
VLBI 1(multi channel sampling), VLBI 2(wide band sampling), GPS Carrier Phase, TWSTFT (DPN: Dual Pseudo random Noises), ETS8 (TCE: Time Comparison Equipment)



About ETS8(TCE), please see the poser : AP-9 Nakagawa et al., "TIME AND FREQUENCY TRANSFER EXPERIMENTS BETWEEN TWO EARTH-BASED CLOCKS USING ETS-VIII SATELLITE"

References

A. Ishii et al., Current status of development of a transportable and compact VLBI system by NICT and GSI, 6th IVS GM Proc., 2010.
H. Takiguchi et al., VLBI MEASUREMENTS FOR TIME AND FREQUENCY TRANSFER, ATF 2008 Proc., 2008.
H. Takiguchi et al., Evaluation of the new approach to improving compact-compact antenna baseline in VLBI, JGU 2009 Abstract, D107-005, 2009.
H. Takiguchi et al., Comparison Study of VLBI and GPS Carrier Phase Frequency Transfer – Part II -, IVS NICT-TDC News, No.30, 26-29, 2009.

'2010 Asia-Pacific Radio Science Conference' (AP-RASC'10), Saturday, September 25, 2010, Toyama, Japan

NiCT Kashima Space Research Center